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ABSTRACT

This paper discusses correlates (not causes) of success in a college chemistry class. It focuses on the immediate and practical concern of identifying those antecedent variables which, because of their close association with success in chemistry, could be used to predict success. Multiple regression analysis determined that the most satisfactory predictors of chemistry grades were measures of mathematical ability, previous study of chemistry, and overall academic achievement. A regression equation was developed which could be used to identify individual students who might, because of inadequate preparation, benefit from tutoring or an alternative course sequence. Suggestions for program development included a cooperative effort toward reducing the likelihood of failure experiences for students through programs which foster cognitive and affective competencies. For those students who do not succeed, colleges should be prepared to offer academic, career, and personal counseling to assist them in evaluating their situation and in choosing wisely among available alternatives. (Author/PC)

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CORRELATES OF SUCCESS IN CHEMISTRY 1A AT UC IRVINE

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PREFACE

Throughout the UC system the elementary courses in general chemistry are regarded as some of the most difficult undergraduates will encounter. At Irvine, the teachers, counselors, and administrators who are involved with students enrolled in Chemistry 1A decided last fall to investigate the factors related to success in the course. The particular objective of this study was to develop empirically a basis for advising students regarding enrollment in Chemistry 1A.

It should be noted that this paper discusses correlates—rather than causes—of success in Chemistry 1A. While it would be interesting to learn which factors cause success or failure in the course, such a determination is methodologically beyond the scope of this investigation. Rather, the paper focuses on the immediate and practical concern of identifying those antecedent variables which, because of their close association with success in Chemistry 1A, can be used to predict it. This path leads most directly toward improved advising of those students who are considering enrolling in Chemistry 1A.

* * * * * * *

Many individuals have contributed substantively to this project. Drs. Everly Fleischer, Fillmore Freeman, and Carol Grimes, the instructors in Chemistry 1A, generously provided time during their classes in which the questionnaire could be administered. Encouragement and financial support were provided by Associate Dean Richard Whalen and Assistant to the Dean Carol Heckman of the School of Biological Sciences, Associate

Dean Robert Doedens and School Counselor Clare Wilkerson of the School of Physical Sciences, Director Donald Polkinghorne of the Counseling Center, and Director Melvin Bernstein of the Office of Studies and Research-Student Affairs. Drs. Charles Lave and Jean Lave of the School of Social Sciences provided conceptual and technical assistance with the regression analysis. Jeff DeCurtins and Bill Kennedy ably performed many of the data management operations.

Credit for the strengths of this paper must be shared with all of these people. For its deficiencies, the authors are alone responsible.

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BACKGROUND

For many freshmen entering the University of California, Chemistry 1A is the first real taste of rigorous academic work. During the past fall quarter at UC Irvine, 1,133 students enrolled in Chemistry 1A. Only 916 completed the course; and, of these, more than 10% received "D's" and "F's."[1]

Since a knowledge of general chemistry is basic to study in the biological and physical sciences, Chemistry 1A is required of all students who major in Biological Sciences, Chemistry, and Physics at UCI. The experience of teachers and counselors suggests that, for many of these students, a number of factors combine to make this course particularly difficult. First, the subject matter presented in the course demands a high level of conceptualization and problem-solving ability. Second, the class lecture sections (averaging more than 300 students) are much larger than those with which recent high school graduates are familiar, generating a reluctance among students to speak up in class or to contact the instructor outside the classroom. Third, many freshmen, having achieved academic success in high school with rather inefficient study habits, simply do not know how to apply their time and energy prudently toward mastery of the subject. Finally, the recognition by students that high course grades are crucial for eventual admission to professional and graduate schools contributes to a widespread sense of anxiety and competitiveness (Appendix A).

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1. These data were provided through the courtesy of UCI Registrar John Brown.

Many freshmen at Irvine do well despite these circumstances; but, for others, failure in Chemistry 1A means disruption of both educational plans and personal esteem. Almost thirty percent of the students who began Chemistry 1A last fall withdrew or failed to earn at least a "C" grade.[2] Academically, these students must wait until next fall to attempt Chemistry 1A again, thus delaying other courses for which it is a prerequisite. Psychologically, the students who are not successful in Chemistry 1A often experience self-doubts and anxiety that affect their performance in other courses.

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2. Of the 1,133 students who enrolled in Chemistry 1A in fall 1973, 217 withdrew, 71 received a grade of "D," and 37 received an "F" grade.

METHOD

Instrument. To collect information from the students enrolled in Chemistry 1A a two-page questionnaire (Appendix B) was developed by the authors. The following topics were covered by the questionnaire:

Background

- Name
- Lecture section of Chemistry 1A
- Declared or anticipated undergraduate major
- Intention to apply to medical school

High school preparation

- Over-all high school grade-point average
- Semesters of high school course-work completed in each of these areas: chemistry, algebra, geometry, trigonometry, and calculus
- Average high school grade in each of these courses: chemistry, algebra, geometry, trigonometry, and calculus

Academic activities during Fall Quarter

- Number of hours spent each week in study for Chemistry 1A
- Number of hours of employment each week
- Number of units of course-work currently enrolled in
- Number of courses dropped from study list since the first day of classes
- Number of courses added to study list since the first day of classes
- Enrollment in either Mathematics 1 or Mathematics 2
- Score on first mid-term examination in Chemistry 1A
- Expected course-grade in Chemistry 1A

Use of resources for assistance with Chemistry 1A

- Instructor (out of class)
- Tutor
- Friend
- Study-skills group
- Extra discussion groups
- Teaching Assistant in laboratory

Evaluation of study-skills groups led by Counseling Center staff

Knowledge of groups
Plans to attend groups
Reasons for not attending a study-skills group
Number of study-skills group meetings attended
Helpfulness of study-skills groups in following areas:
Determining the causes of study difficulties
Improving study habits
Finding other resources such as a tutor, note-taking course, or a counselor

Administration. The questionnaire was administered to students who attended the Chemistry 1A class meetings of December 3 and 4, 1973. In addition, the questionniare was mailed to ninety students who had been identified as having dropped the course between October 12 and November 9, 1973. Of the 916 students who received course grades in Chemistry 1A, 758 (83%) completed questionnaires. However, only 39 (18%) of the 217 students who did not finish the course returned questionnaires; accordingly, data regarding these students have not been considered during most of the analyses.

Supplementary Information. Additional information was collected by the authors from administrative records. The following items were included:

Verbal Scolastic Aptitude Test score
Mathematical Scholastic Aptitude Test score
Pre-calculus examination score
Sex of respondent
Admission to UC Irvine through the Educational Opportunity Program
Scores on two mid-term examinations and final examination in Chemistry 1A
Course grade in Chemistry 1A
Tutoring received through the Special Services Office
Enrollment in Subject A
Course grade in English 28 or Humanities 1A

RESULTS

This section presents descriptive statistics for a number of pertinent variables. These statistics, generally in the form of percentages, medians, and means, are (unless otherwise noted) based on all 797 responses to the questionnaire.

Scholastic Aptitude Test Scores. Developed by the College Entrance Examination Board, the Scholastic Aptitude Test (SAT) is used nationally in college admissions decisions. Scores are available for only 70% of Irvine's freshmen since students with more than eleven quarter units of advanced standing are not required to submit this information. The median verbal SAT score for Chemistry 1A respondents was 530, corresponding to the 60th percentile of the national norms. Particularly interesting is the median mathematical SAT score of 590 for Chemistry 1A respondents, corresponding to the 80th percentile of the national norms. On this measure of mathematical ability, the respondents scored significantly higher than their peers across the country.

High School Preparation.

CHEMISTRY. Nine out of ten respondents who enrolled in Chemistry 1A had completed two semesters of chemistry in high school (Appendix C). Three percent had taken chemistry for one semester, and 7% had not studied chemistry previously. More than half of these students had received an "A" grade in high school chemistry, and another 36% had earned at least a "B" (Appendix D).

ALGEBRA. Almost two-thirds of the respondents had finished four semesters of algebra. Thirty-three percent has studied algebra for two

semesters, and the balance (less than 2%) had completed one semester. Fifty-five percent reported an "A" grade, and 36% had a "B" average.

GEOMETRY. Ninety-five percent of the respondents had studied geometry for at least two semesters, while less than one percent had not taken geometry in high school. More than half of the respondents had earned an "A" in high school geometry, and 38% had received a "B."

TRIGONOMETRY. Trigonometry was less frequently studied than the other fields of mathematics. Thirty-eight percent of the respondents had completed two semesters of trigonometry, and 46% had finished one semester; 16% had not studied trigonometry. As in other mathematics courses, about half of the students had received an "A" and slightly less than 40% had earned a "B."

Academic Majors. Seventy-seven percent of the respondents reported that they were majoring in Biological Sciences. Seven percent were studying Engineering, 4% Chemistry, and 5% either Physics or Mathematics. Seven percent were enrolled in other programs.

Interest in Medical School. Forty-five percent of the respondents expressed the intention of applying to medical school. This is consistent with the findings of a study of entering freshmen conducted last fall.[3]

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3. In response to the 1973 Student Information Form, 64% of the Biological Sciences freshmen and 10% of the Physical Sciences freshmen indicated that they planned to earn an M.D., D.O., D.D.S., or D.V.M. degree. In addition, 17% of the Biological Sciences freshmen and 43% of the Physical Sciences freshmen reported the expectation of pursuing a doctoral degree in an academic discipline. (Norman Lynn Bailiff, Jr. and C. E. Christian, "Attributes, Attitudes, and Aspirations: A Statistical Profile of the Current Freshman Class at UC Irvine," Office of Studies and Research-Student Affairs.)

Academic Assistance. The respondents reported that they relied on their friends for assistance with the course material in Chemistry 1A much more frequently than on other resources.

Source of Assistance	Number of Contacts None	One	Two	≥Three
Friend	23%	8%	16%	53%
Extra discussion group	60%	9%	9%	22%
T.A. in Laboratory	61%	11%	12%	16%
Instructor (out of class)	64%	16%	9%	11%
Tutor	89%	4%	1%	6%
Study-skills group	90%	5%	2%	3%

Other Variables. Sixty-five percent of the respondents were male and 35% were female. The average course-load reported by respondents was 15 units, and the average amount of time devoted to studying Chemistry each week was eight hours. Forty-five percent of the respondents indicated that they were employed during the fall quarter, averaging 16 hours of work each week.

Course Grades in Chemistry 1A. More than half of the students who completed Chemistry 1A received grades of "A" or "B."

Course Grade	Percentage	Cumulative Percentage
A	18.1	18.1
B	36.0	54.1
C	33.5	87.6
D	8.1	95.7
F	4.3	100.0

ANALYSES

Three types of analyses were performed in this study: correlation analysis, multiple regression analysis, and discriminant function analysis. In the following section, each is briefly described and the results are presented.

Simple Correlation. A correlation coefficient indicates the degree of association between two variables. In other words, a correlation coefficient describes the change that occurs in one variable with corresponding changes in a second variable. A coefficient with a value near zero indicates that the two variables are unrelated, while a "large" coefficient (approaching plus or minus one) indicates that the variables are closely related.

The correlation matrix on the following page presents correlation coefficients for the important variables in the study. In the bottom row are entered the coefficients of correlation between the Chemistry 1A course grade (C1AGR) and other variables. The two largest coefficients (.98 with ZSCORE and .74 with EC1AGR) must be explained before considering more substantive relationships. Since course grades in Chemistry 1A (C1AGR) were determined largely by adding each student's scores on three tests, they are very similar to the sum of each student's test scores which had been standardized (converted to "z-scores") before summing (ZSCORE). The high correlation between Chemistry 1A grades (C1AGR) and expected Chemistry 1A grades (EC1AGR) suggests that by the ninth week of instruction students can make relatively accurate estimates of their final grades.

Course grades in Chemistry 1A are moderately associated with a number of variables. Because several of these variables (ALGGR, GEOMGR, and

CORRELATION MATRIX OF IMPORTANT VARIABLES

	VSAT	MSAT	PRECAL	SEX	EOP	HSGPA	CHEMSM	CHEMGR	ALGSM	ALGGR	GEOMSM	GEOMGR	TRIGSM	TRIGGR	CALCSM	CALCGR	MEDSCH	WORKHR	C1AST	CRSEIN	EC1AGR	SUBJA	ENGHUM	ZSCORE	C1AGR
VSAT	1.00																								
MSAT	.45	1.00																							
PRECAL	.17	.40	1.00																						
SEX	-.06	.20	.14	1.00																					
EOP	-.21	-.17	-.08	-.06	1.00																				
HSGPA	.17	.16	.24	-.16	-.09	1.00																			
CHEMSM	-.03	-.01	.00	.09	.03	.08	1.00																		
CHEMGR	.11	.20	.24	.02	-.14	.43	.03	1.00																	
ALGSM	.01	.08	.08	.00	-.05	.04	.13	.05	1.00																
ALGGR	-.01	.17	.23	-.06	-.07	.50	.05	.34	.07	1.00															
GEOMSM	-.03	.01	.02	.09	-.05	.06	.38	.03	.25	.05	1.00														
GEOMGR	.05	.22	.24	.04	-.08	.45	.07	.34	.06	.54	.08	1.00													
TRIGSM	.01	.09	.19	.17	-.02	.09	.21	.15	-.04	.13	.27	.19	1.00												
TRIGGR	-.03	.13	.23	-.06	-.02	.35	.03	.29	.02	.47	-.03	.39	.03	1.00											
CALCSM	-.02	.12	.15	.21	.03	.03	.06	.10	-.05	.14	.02	.16	.30	.14	1.00										
CALCGR	.01	.14	.14	-.02	-.08	.22	.02	.15	.01	.17	.04	.16	.03	.28	.08	1.00									
MEDSCH	-.14	-.04	-.03	.17	.14	.02	.03	.03	-.04	.04	-.03	-.01	.05	-.01	.05	.03	1.00								
WORKHR	.00	-.01	-.05	.10	-.01	-.11	-.01	.00	.00	-.04	-.06	-.01	.00	-.01	.04	-.02	-.06	1.00							
C1AST	-.16	-.19	-.09	-.18	.02	.04	-.03	-.02	.04	.02	.06	.01	.02	.05	-.11	.05	.09	-.05	1.00						
CRSEIN	.09	.13	.09	.04	-.01	.08	.12	.12	.02	.08	.11	.09	.10	.05	.10	.05	.08	-.03	-.05	1.00					
EC1AGR	.14	.39	.34	.20	-.09	.20	.09	.32	.14	.27	.05	.28	.17	.27	.18	.15	.19	-.07	-.06	.16	1.00				
SUBJA	-.36	-.23	-.16	.08	.09	-.02	.06	.01	.03	.04	.04	.04	.00	.01	.02	-.03	.08	-.05	.08	-.12	-.12	1.00			
ENGHUM	.25	.08	.10	-.11	-.07	.26	.05	.16	-.03	.14	.03	.14	.01	.12	-.06	.07	.05	-.09	.03	.11	.18	-.03	1.00		
ZSCORE	.23	.45	.39	.11	-.13	.38	.14	.39	.11	.37	.06	.35	.18	.35	.16	.17	.06	-.09	-.03	.14	.74	-.12	.27	1.00	
C1AGR	.23	.44	.39	.11	-.12	.37	.13	.38	.10	.36	.06	.35	.18	.35	.16	.19	.05	-.08	-.02	.14	.74	-.13	.27	.98	1.00

EXPLANATION OF ABBREVIATIONS APPEARING IN CORRELATION MATRIX

VSAT	Verbal Scholastic Aptitude Test score
MSAT	Mathematical Scholastic Aptitude Test score
PRECAL	Pre-calculus Examination score
SEX	Sex
EOP	Educational Opportunity Program admission to UCI
HSGPA	Over-all high school grade-point average
CHEMSM	Semesters of high school chemestry
CHEMGR	Average high school chemistry grade
ALGSM	Semesters of high school algebra
ALGGR	Average high school algebra grade
GEOMSM	Semesters of high school geometry
GEOMGR	Average high school geometry grade
TRIGSM	Semesters of high school trigonometry
TRIGGR	Average high school trigonometry grade
CALCSM	Semesters of high school calculus
CALCGR	Average high school calculus grade
MEDSCH	Intention of applying to medical school
WORKHR	Hours employed per week during fall quarter
C1AST	Hours studying for Chemistry 1A each week
CRSEUN	Units of course-work carried during fall quarter
EC1AGR	Expected Chemistry 1A course grade
SUBJA	Enrollment in Subject A during fall quarter
ENGHUM	Humanities 1A or English 28 course grade
ZSCORE	Sum of the z-scores for Chemistry 1A tests*
C1AGR	Chemistry 1A course grade

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*By converting raw scores for an individual on a series of tests to "z-scores," an instructor can sum the scores without introducing distortion. In computing z-scores, the class average on a test is assigned the value "0" and an individual's performance is described in standard deviation units from the class average.

Variable	Correlation Coefficient (r)
Mathematical SAT scores (MSAT)	.44
Pre-calculus Examination scores (PRECAL)[4]	.39
Average high school chemistry grade (CHEMGR)	.38
Over-all high school GPA (HSGPA)	.37
Average high school algebra grade (ALGGR)	.36
Average high school geometry grade (GEOMGR)	.35
Average high school trigonometry grade (TRIGGR)	.35

TRIGGR) are measures of mathematical achievement in high school, one of them might represent the group for practical purposes. Even with this reduction, most of the variables on the list are inter-related conceptually and statistically (reflected by the correlation coefficients in the range of .25 to .50).[5] Regardless of this redundancy, this is evidence that students who have done well in high school chemistry and mathematics tend to do well in Chemistry 1A.

There were several variables which, contrary to the authors' expectations, were not related to the grade received in Chemistry 1A. Each of these variables accounted for less than 2% of the variation in the course grade.

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4. The Pre-calculus Examination is administered by the Department of Mathematics at UCI during Orientation Week to determine admission to Mathematics 1 and 2.

5. The correlation coefficients for the five variables involving high school grades are probably underestimates. Since students with low ("C" or less) grades are infrequently admitted to the University, the range of variation for these variables is necessarily restricted, reducing the apparent magnitude of the correlation coefficients.

Variable	Correlation Coefficient (r)
Units of course-work carried during fall quarter (CRSEUN)	.14
Admission to UCI through the Educational Opportunity Program (EOP)	-.12
Sex of respondent (SEX)	.11
Hours employed per week during fall quarter (WORKHR)	-.08
Intention of applying to medical school (MEDSCH)	.05
Hours studying for Chemistry 1A each week (C1AST)	-.02

Multiple Regression. Multiple regression analysis is a procedure for developing a linear combination of variables which have the highest possible correlation with a variable called the "criterion"—in this case, the course grade in Chemistry 1A. Frequently this multivariate procedure permits a better understanding of the relationship among a group of variables than bivariate correlation analysis (described in the previous section). The equation formed in this multiple regression analysis can be used (1) to assess the relationship between each component variable and the Chemistry 1A course grade independent of the influence of other variables and (2) to estimate the grade a student will receive in Chemistry 1A. It should be noted that the best combination of variables might not include those variables which individually have the highest correlation coefficients with the criterion; if several variables are closely related (as in the case of high school mathematics course grades), one variable will tend to represent the group and the others will not appear in the equation.

The equation which produces the largest correlation coefficient with Chemistry 1A grades includes five variables: mathematical SAT score (MSAT), average high school trigonometry grade (TRIGGR), average high school chemistry grade (CHEMGR), over-all high school grade-point average (HSGPA), and Pre-calculus Examination score (PRECAL). This equation yields a correlation coefficient of .61 and an "r^2" of .372.[6] Since the Pre-calculus Examination score is not available until after the student has enrolled in fall quarter classes, it is of little practical value in making a decision about enrolling in Chemistry 1A. When the Pre-calculus Examination score is removed from the equation, the r^2 falls to .355 (Appendix E). By using this equation,[7] slightly more than one-third of the variation in Chemistry 1A grades can be accounted for.

Discriminant Functions. In discriminant function analysis, variables are evaluated on the basis of their effectiveness in properly placing individuals in predetermined categories. For this analysis, students who completed Chemistry 1A were classified as "successful" if they received a course course grade of "A," "B," or "C" and as "unsuccessful" if they received a "D" or an "F." In contrast to multiple regression analysis, through which

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6. The square of a correlation coefficient (r^2) is often used to evaluate the importance of a statistical relationship. For example, if the correlation between two variables is .70, then it is usually said that the variation in the "independent" variable accounts for one-half of the variation in the "dependent" variable (.70 x .70 = .49).

7. Chemistry 1A grade = (.01) MSAT + (.26) TRIGGR + (.26) CHEMGR + (1.20) HSGPA - 10.67. Since the standard error of estimate for this equation is approximately 2, there is a 68% probability that a student with a predicted grade of, for example, "B+" would actually receive a grade in the range of "A" to "B-."

a prediction of the level of success is sought, discriminant function analysis attempts only to predict in which of two categories an individual belongs, given certain information about that individual (e.g., test scores, course grades, and the like).

Only 12 of the 23 variables used in the regression analysis had sufficiently complete data to be considered in the discriminant function analysis (Appendix F). The contribution of each of the 12 variables was statistically significant at the ($p < .01$) level. As predictors of success or failure in Chemistry 1A, the combination of 12 variables was accurate about three-quarters of the time: of the 495 respondents classified as "successful," 368 (74%) were correctly predicted, as were 26 (76%) of the 34 "unsuccessful" respondents.

DISCUSSION

Analytic Procedures. Since the purpose of this study was to provide students and their counselors with a procedure for estimating the student's probable level of achievement in Chemistry 1A, the use of multiple regression analysis was indicated. This analysis determined that the most satisfactory predictors of Chemistry 1A grades were measures of mathematical ability, previous study of chemistry, and over-all academic achievement. A regression equation was developed which could be used to identify individual students who might, because of inadequate preparation, benefit from tutoring or an alternative course sequence.

It became evident through a review of class rosters, however, that the problem of advisement involves more than the students who receive unsatisfactory grades in the course. While 10% of the students who originally enrolled in Chemistry 1A did in fact receive "D" or "F" grades, almost twice as many students withdrew from the course before the end of the term. Because the course is offered only in the fall quarter, these students must—like their classmates who failed the course outright—wait until the next fall to attempt the course a second time.

Consequently, the scope of the study was broadened to include testing a procedure which might effectively distinguish between those students who are "successful" (insofar as earning a course grade of "C" or higher) in Chemistry 1A and those students who either fail or withdraw from the course. However, because the response-rate from students who had withdrawn from Chemistry 1A during the fall quarter was unacceptably low (18%), the discriminant function analysis contrasted students who received a grade

of "A," "B," or "C" with those who received a "D" or "F," disregarding students who had withdrawn. In spite of the fact that the number of variables available for inclusion in this analysis was limited by the absence of pertinent data for all students, a modest level (75%) of predictive accuracy was achieved. Thus, the application of the discriminant function analysis technique to the question of successful completion of the course might be productively undertaken in the future.

Implications for Program Development. The clear relationship between success in Chemistry 1A and mathematical ability suggests the importance of abstract reasoning and quantitative problem-solving. Accordingly, efforts directed toward tutoring or teaching learning-skills should emphasize the improvement of such reasoning and problem-solving skills. Close liaison among the Chemistry Department faculty, the school counselors, and the Counseling Center staff would be paramount in developing a pilot learning assistance program specifically designed for these students.

The intellective variables in the regression equation account for 37% of the variation in Chemistry 1A grades. Presumably much of the remaining variation may be ascribed to motivational variables, some operating positively and others negatively. For example, the high level of anxiety generated in Chemistry 1A students might produce avoidance of studying, inability to concentrate effectively during studying, and impairment of information retrieval and reasoning during tests. Learning-skills courses for students in the Chemistry 1 series could incorporate training in specific behavioral techniques for coping with these problems.

Finally, the main thrust of our co-operative efforts should be toward reducing the likelihood of failure experiences for students through programs which foster cognitive and affective competencies. It is crucial to involve students in these programs before they have succumbed to defeatism in the face of academic difficulty encountered during their first quarter. Further, for those students who do not succeed, we must be prepared to offer academic, career, and personal counseling which assists them in evaluating their situation and in choosing wisely among available alternatives. Since the desire to attend medical school is not correlated with success in Chemistry 1A, some students will need guidance in deciding whether their career aspirations are realistic and in planning meaningful educational experiences.

APPENDIX A. JOURNALISTIC DISCUSSION OF COMPETITIVENESS AMONG PRE-MEDICINE STUDENTS

Cutthroat Pre-Meds *

Always fierce, competition to get into U.S. medical schools this year has reached unparalleled heights—and depths. The number of would-be physicians has increased enormously over the past decade, but medical school expansion has not kept pace. Some 41,000 applicants are fighting for a scant 14,400 places. At many universities, pre-med students are engaged in a sort of academic guerrilla war to assure not only higher grades for themselves but also lower grades for their competing classmates. The result is an unhealthy atmosphere that could hurt the quality of American medicine.

In the grind for high grades, many pre-med students give up extracurricular activities and a normal social life in favor of almost unbroken stretches of studying. "People have become so obsessed with what grade they are getting that what they are learning becomes secondary," says James Young, 20, a Duke University junior. "I know a lot of people who started out pre-med and would have made excellent doctors, but who dropped out because of the competition and the grades." Those who stay on keep closemouthed about what they have learned. Shared studying among pre-meds is rare; a student who asks another for help may get an unhelpful "I don't know"—or worse, a deliberately misleading answer.

Dry-Labbing. Says Carol Asada, 22, a pre-med junior at U.C.L.A. and president of Medicus, a pre-med student organization: "There's a lot of hostility and jealousy among students who are getting top scores." Complains another pre-med: "They're afraid if they tell you something you may get a better score than theirs." Few friendships survive such pressures. "One person might have a copy of last year's exams in a course and absolutely won't show it to anyone else," moans another Duke student.

In some cases, the competition turns into sabotage. Students take important books out of the school library and keep them so long that no one else can use them; a few have gone so far as to tear out crucial pages, making the books useless to other students. Pre-meds are also not above doctoring each other's laboratory work, adding extra ingredients to a classmate's chemistry experiments, or coughing in somebody else's culture dishes—thus starting unwanted bacteria colonies that ruin experiments. Caryn Lum, 20, a Stanford University senior who was recently accepted by two medical schools, tells of a friend who placed his samples from a qualitative analysis laboratory in an oven to incubate overnight; when he went to check them in the morning, they were gone—presumably stolen by a rival. Other students resort to "dry-labbing": faking the results of experiments on paper. Despite the possibility of stiff penalties for those who get caught, cheating in examinations has become widespread.

Columbia University's College of Physicians and Surgeons, for one, has taken steps to curb the competition by placing less importance on an applicant's test scores and searching for students with broad academic backgrounds and a record of participation in extracurricular activities. But many admissions officers still look mainly at grades and test scores, and automatically reject applicants if their marks are below a certain average, thus encouraging desperate competition.

"This atmosphere of opportunistic expediency does not augur well for the medical profession," says Frederick Hofmann, head of admissions at Columbia's medical school. He is right. Cutthroat medical students could well make cutthroat physicians.

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*Time, CIII (May 20, 1974), p. 62.

APPENDIX B.

For coder's use only

CHEMISTRY 1A SURVEY

1-5 ID _____

7-9 VSAT _____

10-12 MSAT _____

13-14 PCE _____

15-17 C1AG _____

18 POE _____

This questionnaire is designed to collect background information about students who have been enrolled in Chemistry 1A during Fall Quarter, 1973. The information you provide will be used in advising future Irvine students as they decide about enrolling in Chem 1A.

We are asking for your name so that we can add other information (like final course grade) at a later time. Your identity and responses will be kept in strictest confidence by the research team from the Counseling Center and the Office of Student Affairs-Studies and Research.

Thank you for your help.

1. Name _____ 2. Chem 1A Section A B C

3. Over-all high school grade-point average _____ 20-21 _____

4. For each of the following high school courses, please
   (1) circle the number of semesters you have taken and
   (2) write in your average grade (use A, A-, B+, B, etc.).

Course	Semesters						Average Grade	
Chemistry	none	1	2	3	4	>4	_____	22,23 _____
Algebra	none	1	2	3	4	>4	_____	24,25 _____
Geometry	none	1	2	3	4	>4	_____	26,27 _____
Trigonometry	none	1	2	3	4	>4	_____	28,29 _____
Calculus	none	1	2	3	4	>4	_____	30,31 _____

5. What is your declared or anticipated undergraduate major?
   _____ 32-33 _____

6. Do you intend to apply to medical school? yes no 34 _____

7. How many hours, each week, are you employed? _____ 35-36 _____

8. What is the average number of hours each week that you have spent studying for Chemistry 1A? _____ 37-38 _____

9. What was your score on the first test in Chem 1A? _____ 39-40 _____

10. How many units of course-work are you taking this quarter? _____ 41-42 _____

11. How many courses have you dropped from your study list since the first day of classes? _____ 43 _____

12. How many courses have you added to your study list since the first day of classes? _____ 44 ____

13. Are you taking either Math 1 or Math 2 this quarter? _____ 45 ____

14. When you had questions about the material presented in Chemistry 1A, how many times did you use each of the following?

a. Instructor, out of class	_____	46 ____
b. Tutor	_____	47 ____
c. Friend	_____	48 ____
d. Study-skills group	_____	49 ____
e. Extra discussion groups	_____	50 ____
f. Teaching Assistant in lab	_____	51 ____
g. Other; specify _____	_____	

15. What course grade do you expect to receive in Chemistry 1A? _____ 52 ____

THE REMAINING QUESTIONS REFER TO THE STUDY-SKILLS GROUPS HELD IN OCTOBER BY MARION JACOBS, DON POLKINGHORNE, OR BONNIE RING.

16. Did you know about the groups? yes no 53 ____

17. Did you sign up to attend? yes no 54 ____

18. If you didn't attend a study-skills group, which one of the following most nearly represents your reason? 55 ____

a. Did not need help.
b. Did not hear about it.
c. Did not have the time.
d. Groups met at an inconvenient time.
e. Did not think they would be useful.
f. other; specify _____

19. How many meetings did you attend? _____ 56 ____

20. Using the rating scale, indicate how helpful the study-skills groups were in each area below.

"1" is "not helpful at all" "3" is "moderately helpful"
"2" is "slightly helpful" "4" is "very helpful"

_____ a.	Determining the causes of study difficulties in Chemistry 1A	57 ____
_____ b.	Improving study habits	58 ____
_____ c.	Finding other resources such as tutors, note-taking courses, counselor	59 ____

12/3/73

APPENDIX C. SEMESTERS OF HIGH SCHOOL COURSES COMPLETED BY RESPONDENTS (N=797)

Semesters Completed	High School Chemistry		High School Algebra	
	Percentage	Cumulative Percentage	Percentage	Cumulative Percentage
>Four	0.4	0.4	7.1	7.1
Four	4.0	4.4	58.5	65.6
Three	1.1	5.5	8.3	73.9
Two	84.1	89.6	24.2	98.1
One	3.2	92.8	1.5	99.6
None	7.2	100.0	0.0	99.6

	High School Geometry		High School Trigonometry	
	Percentage	Cumulative Percentage	Percentage	Cumulative Percentage
>Four	0.4	0.4	0.1	0.1
Four	3.3	3.7	2.3	2.4
Three	2.4	6.1	0.9	3.3
Two	89.0	95.1	35.1	38.4
One	4.2	99.3	45.9	84.3
None	0.7	100.0	15.7	100.0

APPENDIX D. AVERAGE HIGH SCHOOL COURSE GRADES EARNED BY RESPONDENTS (N=797)

Average Course Grade	High School Chemistry		High School Algebra	
	Percentage	Cumulative Percentage	Percentage	Cumulative Percentage
A	42.2	42.2	42.9	42.9
A-	12.0	54.2	12.0	54.9
B+	10.3	64.5	10.9	65.8
B	23.4	87.9	22.9	88.7
B-	3.0	90.9	2.7	91.4
≤C+	9.1	100.0	8.6	100.0

	High School Geometry		High School Trigonometry	
	Percentage	Cumulative Percentage	Percentage	Cumulative Percentage
A	48.0	48.0	44.9	44.9
A-	6.0	54.0	5.1	50.0
B+	8.8	62.8	6.0	56.0
B	26.9	89.7	29.8	85.8
B-	2.7	92.4	3.0	88.8
≤C+	7.6	100.0	11.2	100.0

APPENDIX E. COEFFICIENTS AND T-RATIOS OF SELECTED VARIABLES IN REGRESSION EQUATION PREDICTING CHEMISTRY 1A GRADE (N=750)

Dependent Variable: C1AGR (Chemistry 1A Grade)

Variables in Regression Equation

Variable	Regression Coefficient	T-Ratio	Beta Coefficient**
MSAT	0.0131	11.7	.35
TRIGGR	0.2605	6.0	.19
CHEMGR	0.2584	5.6	.19
HSGPA	1.2029	5.1	.17

r^2 = .355

Standard error of estimate = 1.9905

Constant (residual) = -10.6684

Other Variables (If Entered as Next Term in Regression Equation)

Variable	T-Ratio*	Partial Correlation
PRECAL	4.6	.17
CHEMSM	3.7	.13
TRIGSM	3.5	.13
CALCSM	2.6	.09
ALGGR	2.5	.09
SEX	2.5	.09
GEOMGR	2.1	.08
MEDSCH	2.0	.07
ALGSM	1.6	.06
GEOMSM	1.6	.06
VSAT	0.9	.03
CALCGR	0.7	.03
EOP	0.6	-.02

*T-ratios exceeding 1.96 are statistically significant at the ($p<.05$) level.

**Beta coefficients are standardized regression coefficients.

APPENDIX F. MEAN SCORES ON SELECTED VARIABLES FOR SUCCESSFUL AND UNSUCCESSFUL CHEMISTRY 1A STUDENTS (N=529)

Variable	Mean for Successful Students*	Mean for Unsuccessful Students**	F-Ratio***
TRIGGR	7.39	5.71	24.07
EOP	1.05	1.18	16.71
HSGPA	3.64	3.41	12.43
TRIGSM	1.56	1.29	9.96
CHEMGR	7.64	6.53	8.36
SEX	1.69	1.79	7.16
ALGGR	7.70	6.94	6.22
ALGSM	3.52	3.59	5.47
GEOMSM	2.13	2.03	4.88
MEDSCH	1.47	1.47	4.39
CHEMSM	2.11	2.06	3.99
GEOMGR	7.66	6.91	3.66

Values for variables

Course grades (ALGGR, CHEMGR, GEOMGR, AND TRIGGR): "A" is 9, "A-" is 8, "B+" is 7, "B" is 6, "B-" is 5, "C+" is 4, "C" is 3, "C-" is 2, "D or lower" is 1.

EOP: "admission to UCI through the Educational Opportunity Program" is 2, "regular admission" is 1.

SEX: "male" is 2, "female" is 1.

MEDSCH: "intends to apply to medical school" is 2, "does not intend to apply to medical school" is 1.

HSGPA: "A" is 4, "B" is 3, "C" is 2, "D" is 1, and "F" is 0.

*Mean scores for students who received an "A," "B," or "C" grade in Chemistry 1A. (N=495)

**Mean scores for students who received a "D" or "F" grade in Chemistry 1A. (N = 34)

***F-ratio for discriminant function analysis. All F-ratios are statistically significant at the ($p < .01$) level.